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INSTRUMENT FOR CHECKING THE EARTH CONTENT IN PULP

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[Figures referred to are appended.]

In highly efficient dredging operations, a constant check of the earth content in the pulp is essential in order to accurately estimate the volume of earth removed.

At present there are no reliable instruments which can indicate with a sufficient degree of accuracy the percentage of earth content in pulp, or register the total amount of earth removed. In the absence of such instruments, the solid content of pulp fluctuates within wide limits (from 5 to 40 percent). Taking into consideration the danger of clogging pipes with saturated pulp, the general practice is to maintain a low content of solid matter for efficient operation.

At the Central Scientific Research Laboratory of Physical Methods for the Investigation of Materials, Main State Inspectorate for Boiler Supervision, Ministry of Electric Power Stations and the Electrical Industry, an instrument was developed by Ye. G. Kardash to measure the percent of earth content in pulp and to indicate the total amount of earth removed in cubic meters.

The operation of this device is based on the differential penetration of the pulp within the dredging pipe by gamma rays from artificial radioactive substances (isotopes).

The source of gamma radiation (see Figure 1) is located on one side of the pipe 1 (usually under it), while on other side of the pipe is located a Gieger counter, a gamma-ray indicator or an ionization chamber 2. In the case being described an ionization chamber was used. Gamma rays from a number of radioactive sources can penetrate more than 300 mm of steel or 1.5 m of water. Since the absorption of gamma rays is proportional to the content of solids in the pipeline, the quantity of gamma rays reaching the ionization chamber is inversely proportional to pulp density. Gamma rays entering the ionization chamber knock electrons from its walls and ionize the air in the chamber, setting up an ionization current whose magnitude is proportional to the gamma-ray intensity. This current is amplified by the highly stable dc amplifier 3 and passed to the pointer-type measuring instrument 4, which is graduated in percent content of solids in the pulp.

To measure cubic meters of soil removed, an auxiliary amplifier -- the mixer 5 with a dc ampere-hour meter 6 connected to its output -- was used.

If the rate of pulp flow were constant, the meter could be graduated directly in cubic meters. However since the rate of pulp flow varies, it must be taken into account. Several well-known methods can be used; for example, a Venturi flow meter with differential manometer 7 which controls a potentiometric transmitter (variable electric resistance) connected to the circuit of the auxiliary amplifier and the earth volume meter.

The isotope cobalt-60, which is widely used at present for industrial defectoscopy, was used in this case. The cost of enough of this substance for one instrument does not exceed a few tens of rubles. In considcration of safety to personnel, the radioactive substance is enclosed in a lead container. This container is provided with a slit for directing a narrow beam of gamma rays at the ionization chamber.

This instrument (see Figure 2) was tested on two dredges in productive operations on the Volga river sandbanks, deepening the channel and building up levees. The accuracy of this device was checked by taking control samples. Figure 3 shows a graph comparing readings of the calibrated instrument with data from the control samples. Conformity of the curves was fully satisfactory, with errors not exceeding inaccuracies in the control sample measurements.

The sensitivity of this instrument was fully satisfactory, when installed either on a vertical section of pipe or on a horizontal section immediately following a vertical section. Its installation did not require any alterations in the pipeline. The recording part of the instrument was installed in the control room. The lighting circuit of the dredge was utilized for the power supply.

Neither meteorological conditions, rocking [of the dredge], chemical admixtures in the water or soil, nor any other factors affected the operation of the instrument.

The suitability of this instrument for widespread use has been amply proven by the results of investigation.

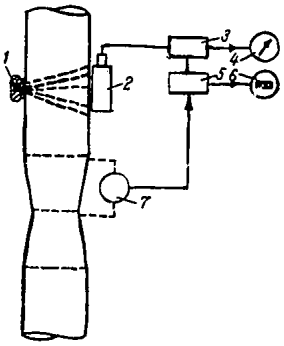


Figure 1. Diagram of the Instrument for Measuring Earth Content in Pulp

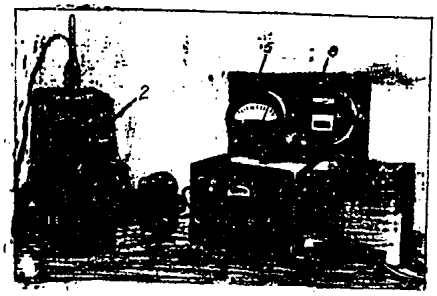
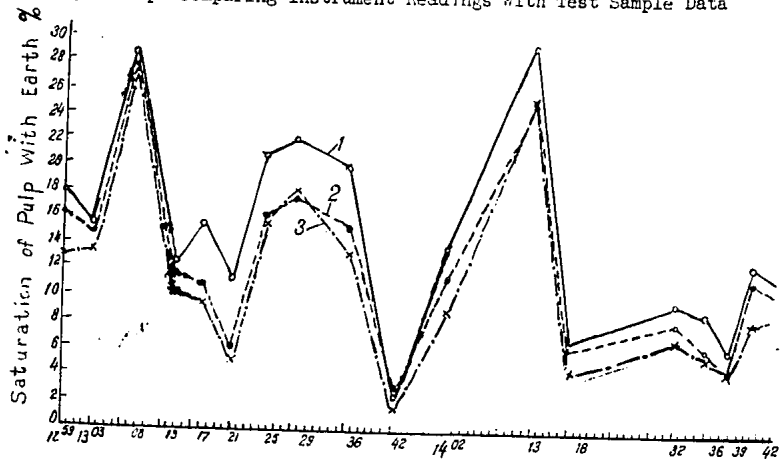


Figure 2. Photograph of the Instrument for Measuring Earth Content in Pulp

1. Lead container with ampule.
2. Ionization chamber.
3. Amplifier for determination of pulp density.
4. Auxiliary amplifier for determination of output of the dredge.
5. Pulp density indicator.
6. Output indicator.

Figure 3. Graph Comparing Instrument Readings With Test Sample Data



Time when readings and test samples were taken.

1. Readings of the instrument.
2. Saturation of pulp with earth in test samples (gravimetric).
3. Saturation of pulp with earth in test samples (volumetric).

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